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DESIGN OF RESEARCH-BASED LAB SHEETS FOR THE ACQUISITION OF SCIENCE COMPETENCIES USING ICT REAL-TIME EXPERIMENTS. DO STUDENTS GET THE POINT OF WHAT THEY ARE DOING?

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Abstract: This study is part of a European project that aims to design new microcomputer-based laboratory (MBL) activities to be used in secondary and high school to enhance on students scientific competencies. The aim of this work is to design and to implement research-based teaching materials that take advantage of the use of MBL and promote scientific competencies in students.

Researchers from six universities belonging to five EU countries have collaboratively designed a new research-based framework for MBL activities. Activities are context-based and inquiry guided. When students take experimental data, it is proposed a Predict-Observe-Explain (White & Gunstone, 1992) sequence. The main scientific competencies that the designed activities aim to enhance in students are the design of experiments, the interpretation of results and its communication. First versions of activities have been translated into national languages (German, Czech, Slovak, Finnish and Catalan) to be implemented. The study has been conducted with 865 students from five countries who have implemented the activities. Students answered a post-implementation questionnaire to elicit if they believed that they knew the objectives of the activities and if they really did. They were also asked if MBL helped them to interpret the results and if the activity could have been done without such equipment.

Results obtained in this study suggest that the research-based learning materials designed to work with MBL are useful and of quality as most students in different countries understand the point of the activities, and most of them think that these activities help them to learn and that the activities could not be done without MBL. Nevertheless, differences in results have been obtained for some activities. The results of this research will be used to refine teaching materials.

Keywords: science competencies, MBL microcomputer based laboratory, secondary school science, competencies in the laboratory

BACKGROUND

This study is part of a European project that aims to design new microcomputer-based laboratory (MBL, Thornton 1990) activities to be used in secondary and high school to enhance on students scientific competencies. Performing MBL, also called real time experiments, allows students to work out many features of science competencies, having a quick and continuous interaction with new learning that they acquire. In this technology (Figure 1) one or more sensors are connected to an interface and/or to a computer so that the results of the experiment are obtained in real time. That is students can see the graphs of the experiment at the same time that they are obtained.

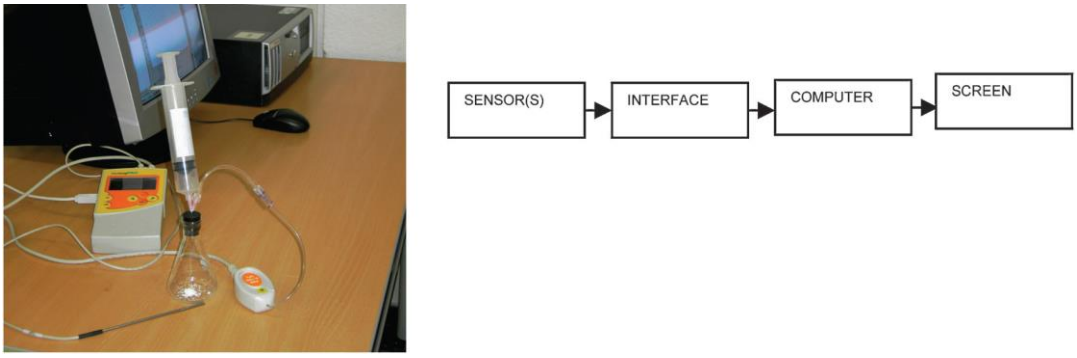

Figure 1: Example of Microcomputer Based Laboratory Technology. Students can see the results and the graph of the experiment in real time (image M. Tortosa).

This tool supports a constructivist view of education and allows working high order learning skills (Aksela, 2005). A user-friendly data logger supports a better teacher implementation (Lavonen et al, 2003). Sheppard (2006) states that MBL equipment, used with a Prediction-Observation-Explanation (POE) view is a powerful tool to evaluate students' learning in a great variety of topics.

The proposal of MBL instructions presented as an inquiry-guided activity and structured as a learning cycle has revealed to be effective in achieving significant learning. A classroom management style that promotes student verbalization and interaction is desired. It is important to minimize technical complications assuring a assuring a good experience of using the hardware and software. Previous research-based frameworks for practice in MBL activities have been suggested (Pintó et al, 2010; Espinoza & Quarless, 2010; Tortosa, 2012). Students generally express that MBL is easy-to-use technology, that motivates them and that it helps them to improve their understanding in science.

Rationale

The aim of this work is to design and to implement research-based teaching materials that take advantage of the use of MBL and promote scientific competencies in students.

The objectives of our work are twofold: (1) To obtain research-based teaching materials on real-time experiments that enhance scientific competencies in secondary and high school students, and (2) to answer the questions: "Do students understand the objectives of the research-based designed activities?", and "Do students feel that MBL helps them learning?"